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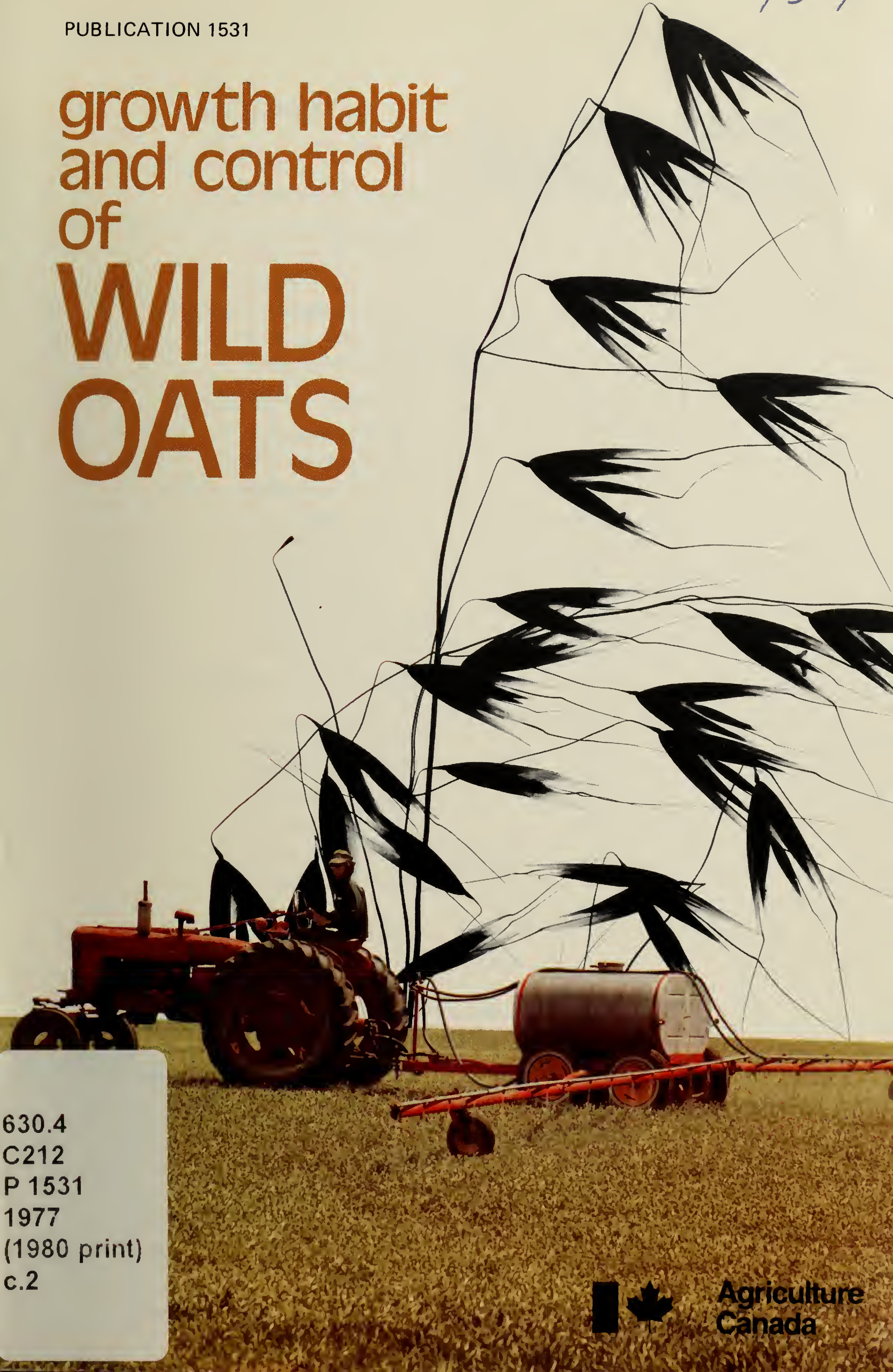
growth habit and control of WILD OATS



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growth habit and control of WILD OATS

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The wild oat (*Avena fatua* L.), our most common and troublesome weed, is well adapted to grow and persist in the cultivated soils of Western Canada. Since its introduction by the early settlers, it has flourished and spread. By 1931, it had infested 85% of our cropland (Manson 1932) and 30 years later it still persisted in the same area to about the same extent (Alex 1965), despite efforts to control it culturally.

Although cultural practices are useful, they have limited application. Some practices, such as delayed seeding, depend on field conditions and the weather; if conditions are not suitable, grain yields may be reduced and results disappointing. The need for chemicals to control wild oats selectively was recognized many years ago.

In the period 1960 to 1963, three new herbicides, diallate (Avadex), barban (Carbyne), and triallate (Avadex BW) were introduced to control wild oats in flax, barley, or wheat. Since then, several more herbicides have been recommended for use: trifluralin (Treflan) in certain oilseed crops, asulam (Asulox F) in flax, and benzoylprop ethyl (Endaven) in wheat and rapeseed. Another compound, difenzoquat (Avenge), was added in 1974 for use in barley. In 1975, EPTC (Eptam) and dinitramine (Cobex) were introduced for use in oilseed crops. In 1976, two more compounds were approved for use in demonstration trials. The first, flamprop methyl (Mataven), was used in wheat; the second, dichlorfop methyl (Hoe Grass), was used in wheat, flax, and rapeseed. In addition, a mixture of barban (Carbyne) and benzoylprop ethyl (Endaven) has given good control of wild oats in wheat at a later stage of growth than when barban is used alone. All these treatments have some shortcomings and none can eradicate the wild oat. This publication presents current information on the growth habit of the wild oat and its control by cultural and

chemical means. Further information on formulations and rates of application for the herbicides recommended by each province can be obtained from provincial government publications.

Losses from wild oats, such as yield reduction, dockage, cleaning costs, and lowering of grade and quality, are well recognized. Yield reduction, the most important loss, depends on the density of infestation, the time of removal of the wild oat, the competitive ability of the crop, and its yield potential. Work is currently under way to indicate these effects more clearly, so that growers will have enough detailed information to estimate potential losses in yield.

Competition varies with the crop. Among cereal crops, barley is the strongest competitor against wild oats, followed by rye, wheat, and oats. Flax is a poor competitor (Pavlychenko and Harrington 1934). A good stand of rapeseed wil compete strongly with wild oats, but establishing the stand is sometimes a problem. In studying losses due to weed competition, Friesen and Shebeski (1960) found crop yield reductions ranging from 5 to 50% in fields in which wild oats was the dominant species. Later work (Bowden and Friesen 1967) showed that 48 and 120 wild oats / m^2 (*40 and 100 / sq yd*) decreased wheat yields by 16 and 27% when summerfallow plots were fertilized or by 22 and 37%, respectively, when the plots were unfertilized (Table 1). Similar results were obtained on stubbleland. Further work showed that the longer the wild oats remained in the plots the lower the crop yield (Table 2). Results were similar but more pronounced with flax.

Friesen (1973) reported the effect of different wild oat densities on yields of wheat, barley, flax, and rapeseed where the weed-free yield for the various crops was assumed to be 2, 1.6, 1.9, and 1.7 tonnes / ha (*30 bu / ac*), respectively, and the wild oats emerged at the same time as the crop (Table 3). He noted that the yield was reduced more per weed by the first 10 weeds than by the next 10. Weeds emerging before the crop were more competitive than those that emerged at or after crop emergence (McBeath et al. 1970).

ORIGIN

According to early literature and popular belief, the wild oat (*Avena fatua* L.) is considered to be the wild species that gave rise to our cultivated oat (*Avena sativa* L.). Certain evidence (Griffiths and Johnston 1956) indicates, however, that this may not be the case. Coffman (1946) has advanced the theory that another species, *Avena sterilis*, is the more likely common ancestor of wild and cultivated oats and he suggests that wild oats appeared earlier in the line of descent. Experts agree that Asia Minor is the center of origin of oats and it is interesting to note that *Avena fatua* and *Avena sterilis* are found growing together in that region.

TABLE 1. YIELD OF WHEAT, FERTILIZED AND UNFERTILIZED, IN COMPETITION WITH DIFFERENT DENSITIES OF WILD OATS

	Summerfallow, tonnes / ha		Stubbleland, tonnes / ha			Summerfallow, *bu / ac*		Stubbleland, *bu / ac*	
Wild oats / m^2	Fertilized*	Unfertilized	Fertilized†	Unfertilized	Wild oats / *sq yd*	Fertilized*	Unfertilized	Fertilized†	Unfertilized
0	2.04	2.00	1.96	1.38	*0*	*30.3*	*29.8*	*29.2*	*20.5*
12	1.92	1.78	1.71	1.33	*10*	*28.5*	*26.5*	*25.4*	*19.8*
48	1.71	1.55	1.35	1.26	*40*	*25.4*	*23.1*	*20.1*	*18.7*
84	1.47	1.41	1.23	1.01	*70*	*21.9*	*21.0*	*18.3*	*15.0*
119	1.49	1.26	1.04	0.87	*100*	*22.2*	*18.8*	*15.5*	*13.0*
155	1.38	1.16	0.89	0.77	*130*	*20.6*	*17.3*	*13.2*	*11.4*
191	1.16	1.13	0.79	0.68	*160*	*17.2*	*16.8*	*11.8*	*10.1*
227	1.14	0.95	0.72	0.65	*190*	*17.0*	*14.1*	*10.7*	*9.7*

From Bowden and Friesen (1967).
* 11-48-0 at 56 kg / ha (*50 lb / ac*).
† 16-20-0 at 112 kg / ha (*100 lb / ac*).

TABLE 2. YIELD OF WHEAT WHEN WILD OATS WERE REMOVED AT DIFFERENT STAGES OF GROWTH

Stage of removal of wild oats	Wild oats / m^2				Wild oats / *sq yd*			
	0	119	239	358	0	100	200	300
	Yield of wheat, tonnes / ha				Yield of wheat, *bu / ac*			
Preemergence*	1.45	1.23	1.32	1.01	*21.5*	*19.3*	*19.7*	*15.0*
Two- to three-leaf	1.43	1.06	0.84	0.59	*21.3*	*15.7*	*12.5*	*8.8*
Four- to five-leaf	1.50	0.80	0.75	0.37	*22.3*	*11.9*	*11.1*	*5.5*
Five- to six-leaf	1.51	0.71	0.52	0.35	*22.4*	*10.5*	*7.8*	*5.2*
Shot blade	1.41	0.70	0.38	0.24	*21.0*	*10.4*	*5.7*	*3.6*
Check (not removed)	1.61	0.73	0.44	0.39	*23.9*	*10.8*	*6.5*	*5.8*

From Bowden and Friesen (1967).
* Avadex BW (triallate) at 1.4 kg / ha (*1.25 lb / ac*).

TABLE 3. PERCENTAGE LOSS IN YIELD WITH DIFFERENT DENSITIES OF WILD OATS IN WHEAT, BARLEY, RAPESEED, AND FLAX WHEN THE WEED-FREE YIELD OF THE CROPS IS 2.0, 1.6, 1.9, AND 1.7 TONNES / HA, RESPECTIVELY (*30 BU / AC*)

Wild oat plants		Percentage loss in yield			
per m^2	*per sq ft*	Wheat	Barley	Rapeseed	Flax
0	*0*	0	0	0	0
10	*1*	10.7	7.3	8.0	19.0
21	*2*	15.0	10.3	11.3	27.0
32	*3*	18.7	12.7	14.0	33.0
53	*5*	24.0	16.3	18.0	42.3
75	*7*	28.3	19.3	21.3	50.3
107	*10*	34.0	23.0	25.7	60.0
161	*15*	41.7	28.3	31.3	73.7
215	*20*	48.0	32.7	36.3	

From Friesen (1973).

DESCRIPTION AND HABITS

SEED CHARACTERISTICS

Wild oat seeds vary in color from yellowish white to various shades of gray, brown, or black. At the base of each grain is a horseshoe-shaped scar or sucker mouth and a tuft of hairs. A twisted and bent awn arises from near the middle of the back of each seed. There seems to be no limit to the unwinding and twisting action of the awn. It can be straightened or unwound repeatedly by moist conditions, such as a heavy dew, and returned to its normal bent position by subsequent drying. Another characteristic that distinguishes the wild oat from the cultivated oat is its habit of delayed germination or dormancy. The persistence of wild oats is ultimately determined by whether or not the seeds are dormant when they are exposed to conditions suitable for germination. Seeds that fail to germinate in 10 days at 18°C with a suitable supply of moisture and oxygen are considered to be either dead, or viable but dormant. Dehulling and piercing the ungerminated seeds after 10 days and further exposure to germinative conditions has invariably stimulated germination in the seeds that were alive. The seeds that grew after dehulling and piercing were classed as dormant.

DORMANCY

The initial development of dormancy in the seed, referred to as primary dormancy, depends on the season. Moisture and temperature conditions affect its development. These factors and the natural

variability that exists in a given population make it impossible to predict the number of seeds that will become dormant during ripening. Even when the number that are dormant is known, we do not know if their dormancy is shallow or deep-seated. The mechanism of dormancy in wild oats has been studied (Black 1959; Hay 1962; Naylor and Simpson 1961; Simpson 1965, 1966; Simpson and Naylor 1962), but only a few details of this work are mentioned here. Research (Simpson 1965) has shown that inhibition of germination involves a restriction in sugar production in the endosperm of the seed, due to a block in the release or synthesis of the enzyme maltase, or a restriction in sugar utilization in the embryo axis or the scutellum, the adjacent tissue, or both. These restrictions can be overcome in the laboratory by using different concentrations of gibberellic acid, a naturally occurring hormone in the plant. In further work, Simpson (1966) suggested that loss of dormancy in wild oats may be regulated by the loss of a naturally occurring growth retardant that prevents the synthesis of a gibberellin in the embryo. The onset of seed dormancy can be prevented by treating the developing seeds (Black and Naylor 1959), but we are mainly interested here in the conditions that cause the natural loss of dormancy and how this affects persistence in the field. To determine this, we studied the loss of dormancy in samples stored at various temperatures, the persistence of seeds left undisturbed in the soil at various depths, and the effect of various postharvest treatments on persistence.

TABLE 4. PERCENTAGE OF DORMANT WILD OAT SEEDS FROM A NATURALLY SHATTERED SAMPLE AFTER 1, 2, 3, 4, AND 5 YEARS OF STORAGE AT TEMPERATURES RANGING FROM −17 TO 40°C

	Storage temperature, °C						
Time in storage, years	−17	−17 and 2	2	2 and 18	18	18 and 40	40
	Percentage of dormant wild oat seeds						
Nil	96	96	96	96	96	96	96
1	72	73	84	55	51	33	43
2	93	90	77	54	17	9	—†
3	82	76	63	26	12	4	—
4	32	45*	52	11*	1	6*	—
5	36	76	82	6	1	1	—

From Banting (1966).
* Transferred continuously to the lower temperature after 3½ years.
† Seed supply depleted after 1 year.

Freshly shattered seeds lost their dormancy most readily under warm, dry conditions (Table 4). Of the seeds stored at 18°C or at 18 and 40°C, 1% were still dormant after 5 years. Seeds stored at 40°C would probably have afterripened or lost their dormancy in the shortest period of time, but the supply of seeds was depleted after 1 year. Cool, moist conditions, on the other hand, delayed this process, as shown in another test where seeds were stored in a moist and a dry state. Similar effects were obtained with 'threshed' and naturally shattered seeds.

PERSISTENCE

The number of viable seeds buried at various depths and left undisturbed in the soil decreased rapidly during the first 2 years, especially in seeds near the surface (Table 5). Similar results were obtained in another test in heavily infested soil under natural conditions. By the end of the second year, 8% of the seeds were still viable. The number of viable seeds decreased slowly in subsequent years and after 7 years less than 1% were alive.

The total number of dormant seeds recovered from the different depths decreased with time for a period of 4 years and fluctuated thereafter. The percentage of viable seeds that were dormant fluctuated widely with each sampling date. Variability in the number of dormant seeds was essentially the same at all depths.

A heavy infestation of wild oats was reduced to less than 5% of the original population by summerfallowing for one season and delaying seeding the second season until early June (Banting 1962). A small number of seeds persisted, however, for periods up to 7 years, in sufficient quantity to reinfest the field. Other work has shown that a few seeds can remain viable for the same length of time, or longer, under sod.

Postharvest treatment: The effect of various postharvest treatments on the persistence of seeds that had shattered naturally, and of 'threshed' seeds that had passed through the combine, was studied also. The naturally shattered and 'threshed' seeds, collected on two dates, were (*a*) continuously exposed, (*b*) covered immediately after harvest, (*c*) covered after 3 weeks, (*d*) covered after 6 weeks, and (*e*) covered in June of the following spring. The number that germinated, that were viable, and that were dormant were tested in late October after harvest, mid-June, and early November of the next year.

The number of seeds that germinated varied widely, depending on whether or not the seeds were covered (Table 6). Very few of the seeds on the surface germinated by late October. At this time 42-50% of the early-maturing seeds that were covered had germinated. Germination was 20% higher than this in the late-maturing samples except where the seeds were exposed for 6 weeks. In the latter treatment the seeds had been covered for only 7 days when germination and viability were determined.

TABLE 5. TOTAL NUMBER OF VIABLE AND DORMANT WILD OAT SEEDS AFTER BURIAL IN 5-CM (*2-IN.*) LAYERS OF SOIL TO A DEPTH OF 25 CM (*10 IN.*) AND LEFT UNDISTURBED FOR PERIODS OF 1-7 YEARS. THERE WERE 250 SEEDS PER TREATMENT

	1958 (1 year)		1959 (2 years)		1960 (3 years)		1961 (4 years)		1962 (5 years)		1963 (6 years)		1964 (6 yr 8 mo)	
Depth, cm (*in.*)	V	D	V	D	V	D	V	D	V	D	V	D	V	D
0- 5 (*0-2*)	15.0	7.0	1.0	1.0	8.0	0.0	2.0	1.5	5.0	1.0	1.0	0.0	1.0	0.0
5-10 (*2-4*)	96.0	14.0	19.5	12.5	17.5	1.5	17.5	0.5	6.0	4.0	10.0	1.0	2.0	1.0
10-15 (*4-6*)	93.0	14.0	33.5	18.5	28.5	4.0	14.0	0.5	7.0	7.0	7.0	0.0	2.0	1.0
15-20 (*6-8*)	90.0	46.0	30.5	28.5	19.0	4.0	9.5	0.0	9.0	2.0	8.0	1.0	2.0	2.0
20-25 (*8-10*)	29.0	15.0	16.0	14.0	9.5	1.5	5.0	0.5	4.0	2.0	1.0	0.0	1.0	1.0
TOTAL	323.0	96.0	100.5	74.5	82.5	11.0	48.0	3.0	31.0	16.0	27.0	2.0	8.0	5.0
% of original total	25.8	7.7	8.0	6.0	6.6	0.9	3.8	0.2	2.5	1.3	2.2	0.2	0.64	0.40
% dormancy based on total viable seeds		29.7		74.1		13.3		6.3		51.6		7.4		62.5

Abbreviations: V = viable; D = dormant.
From Banting (1966).

TABLE 6. PERCENTAGE OF WILD OAT SEEDS, FROM EARLY- AND LATE-MATURING THRESHED SAMPLES, THAT GERMINATED, THAT WERE VIABLE, AND THAT WERE DORMANT ON THE SURFACE AND IN THE SOIL BY LATE FALL AND SPRING AFTER VARIOUS PERIODS OF POSTHARVEST EXPOSURE

	Date of observation								
	October 29, 1962			June 15, 1963			November 8, 1963		
Early-maturing samples set out on Aug. 30, 1962	Germinated to date, %	V %	D %	Germinated to date, %	V %	D %	Germinated to date, %	V %	D %
Continuous exposure	0.17	83.85	61.57	0.90	0.25	0.06	0.96	0.25	0.11
Covered immediately	42.20	52.11	48.44	60.08	1.30	1.30	61.11	0.75	0.21
Covered after 3 weeks	49.84	39.15	31.68	58.13	0.65	0.65	58.27	0.34	0.11
Covered after 6 weeks	45.32	50.53	36.33	54.74	0.67	0.67	54.80	0.25	0.07
Covered in June 1963	—	—	—	—	—	—	1.16	0.13	0.02
Stored in laboratory	—	99.00	36.50	—	98.84	19.83	—	100.00	9.00
Late-maturing samples set out on Sept. 10, 1962									
Continuous exposure	0.00	81.78	53.56	0.66	0.07	0.07	0.69	0.06	0.01
Covered immediately	62.08	27.05	23.91	66.95	0.10	0.10	67.04	0.12	0.04
Covered after 3 weeks	71.28	17.77	16.04	74.43	0.35	0.35	74.49	0.12	0.06
Covered after 6 weeks	1.13	83.10	39.29	15.99	0.39	0.39	16.03	0.12	0.02
Covered in June 1963	—	—	—	—	—	—	0.72	0.04	0.02
Stored in laboratory	—	86.00	42.50	—	85.30	3.85	—	84.00	3.79

Abbreviations: V = viable; D = dormant.
From Banting (1966).

As in a previous experiment, there was a great reduction in the number of viable seeds after the first winter. In June of 1963 not more than 1.3% of the original number of seeds were viable in any treatment. The large differences in number of viable seeds on the surface and in the soil that were evident in October had almost disappeared by June and were not apparent in November.

These results raise the question of the value of fall tillage as a means of controlling wild oats. The increased germination after a tillage operation in the fall does not necessarily indicate that more seeds are lost from the soil. However, our tests were not conducted in standing stubble, which would be the normal condition. The test area was surrounded by dense stubble, but trapping of snow by stubble in the immediate area might alter the survival of seeds on the surface.

In none of the tests were differences in persistence established for seeds that had shattered naturally or were threshed (that is, had passed through the combine). Nor were differences found for early- and late-maturing samples. Thus, although the samples had been exposed to different conditions before the experiments started, the same overall pattern in loss of viability was found.

GERMINATION

A certain amount of confusion exists regarding the effect of temperature on the germination of wild oats. Mather (1946) reported that the wild oat germinates best if started at temperatures between freezing and 10°C. In later work, Friesen and Shebeski (1961) reported the optimum temperature for wild oat germination to be 15-21°C. They

TABLE 7. GERMINATION OF WILD OATS AT HIGH HUMIDITY AND VARIOUS TEMPERATURES IN DARKNESS

Temperature, °C	Percentage germination				% dormant	% dead
	Days					
	5	10	15	20*		
4.4	0.0	59.0	72.0	76.0	23.0	1.0
10.0	83.0	92.0	92.0	92.0	7.0	1.0
15.0	97.0	97.0	97.0	97.0	3.0	0.0
21.1	95.0	97.0	97.0	97.0	2.0	1.0
26.6	96.0	96.0	96.0	96.0	1.0	3.0
32.2	3.0	10.0	27.0	64.0	27.0	9.0

From Banting (1973).
* Seed dehulled and pierced after 20 days.

found emergence was slow at 10°C and no germination occurred at 4.4°C. We studied the germination of wild oats at various temperatures and found that the seeds germinated well at temperatures of 10-27°C. Nearly 60% of the seeds germinated in 10 days at 4.4°C and over 80% germinated in 5 days at 10°C (Table 7). The limited range of germination reported by Friesen and Shebeski (1961) might have been caused by dormancy in the seed. In our tests, there was little dormancy at 15°C but more than 20% dormant seeds after 20 days at 4 or 32.2°C and high humidity. The latter condition might apply around the edge of a slough or pothole after a heavy summer rain.

EMERGENCE AND SEASONAL GROWTH

The main flush of germination is in the spring, but some germination may occur throughout the growing season (Table 8). Time of emergence in the spring may vary as much as 3 weeks from year to year. Cool, moist conditions promote maximum emergence and thus the crops seeded early are usually the most heavily infested. Emergence early in the season is usually from shallow depths if moisture is plentiful. If the surface becomes dry, emergence occurs from greater depths. Seedlings can emerge from depths of 20 cm (*8 in.*), if conditions are right, and produce vigorous plants. Wild oats can emerge from greater depths in the soil than most cereals. This is because the first internode or 'mesocotyl' of the wild oat has great powers of extension so that it can push the stem apex and surrounding leaf tissue up in the soil for a considerable distance. This usually allows the first leaf to emerge with the protection of the coleoptile (the sheath surrounding the first leaf). The coleoptile, however, cannot elongate indefinitely and the seed can be so deep that the first leaf sometimes breaks through the coleoptile before it reaches the soil surface. In the latter condition the base of the coleoptile is well below the crown node where it normally exists. The crown node refers to the node below the soil surface where the secondary root system develops.

In wheat, barley, and rye the first internode is very short and remains close to the seed. Thus, the base of the coleoptile remains close to the seed and protection to the enclosed leaf is limited by the amount the coleoptile can elongate, which in Manitou wheat is about 9 cm (*3.5 in.*). This means that when seeds of this variety are sown 13 cm (*5 in.*) deep, the first leaf must push its way up through the soil without protection for a distance of 4 cm (*1.5 in.*). Deep seeding thus delays emergence and produces weak seedlings. Some of our spring wheat varieties can emerge from a considerable depth and from a greater depth than barley. Seeding as shallow as possible into moist soil is thus desirable.

Wild oats may emerge before, with, or after the crop, and so their seasonal growth is not predictable. Short periods of wetting and drying

TABLE 8. EMERGENCE OF WILD OAT PLANTS PER SQUARE METRE (*SQ YD*) THROUGHOUT THE GROWING SEASON, 1959-1963 INCLUSIVE, REGINA, SASK.

	May	June	July	Aug	Sept	Total
(a) Flax — not irrigated						
Total for 5 years	579 (*484*)	320 (*268*)	179 (*150*)	3.6 (*3*)	179 (*150*)	1261 (*1055*)
Av / yr	116 (*97*)	63 (*53*)	36 (*30*)	0 (*0*)	36 (*30*)	251 (*210*)
Yearly total in %	45.9	25.4	14.2	0.3	14.2	100
(b) Flax — irrigated						
Total for 5 years	823 (*688*)	598 (*500*)	482 (*403*)	17 (*14*)	41 (*34*)	1961 (*1639*)
Av / yr	164 (*137*)	119 (*100*)	96 (*80*)	3.6 (*3*)	8.4 (*7*)	391 (*327*)
Yearly total in %	42.0	30.5	24.6	0.8	2.1	100
(c) Smf. — not irrigated						
Total for 5 years	538 (*450*)	604 (*505*)	141 (*118*)	23 (*19*)	179 (*150*)	1485 (*1242*)
Av / yr	107 (*90*)	121 (*101*)	29 (*24*)	4.8 (*4*)	36 (*30*)	298 (*249*)
Yearly total in %	36.2	40.6	9.5	1.5	12.2	100
(d) Smf. — irrigated						
Total for 5 years	658 (*550*)	712 (*595*)	286 (*234*)	27 (*23*)	20 (*17*)	1697 (*1419*)
Av / yr	131 (*110*)	142 (*119*)	55 (*46*)	6 (*5*)	3.6 (*3*)	338 (*283*)
Yearly total in %	38.7	41.9	16.5	1.6	1.3	100

From Molberg and Banting — cited by Banting (1973).

Herbicides have to be used along with cultural practices to control wild oats.

may give the seeds that are ready to grow a faster start than the crop when rain occurs after seeding. Some of the seeds with small sprouts can withstand as much as 7 days drying at 22°C and still grow vigorously when they are moistened again (Table 9). The young sprouts must thus get some fairly good protection from the hull.

The rapid development, early maturity, and ready shattering ability of wild oats are well known. What is less well known is the uneven ripening of seed in the panicle from top to bottom and also in the individual spikelets. Seeds at the tip of the main axis of the panicle may ripen and fall to the ground before the seeds at the base are filled. Differences in dormancy also develop in the primary, secondary, and tertiary seeds of a spikelet (Johnson 1935). It should also be remembered that differences in numerous other characters are to be expected in this (Sexsmith 1967, 1969) and other wild species.

We collected wild oat seeds from the field at various intervals after pollination and dried them at 40°C for 9 weeks before testing their viability. We found that 4% were alive when collected 4 days after pollination and over 90% were alive when collected 6 days after pollination.

The initial or primary dormancy that develops in the seed as it matures may disappear in the field. As noted above, warm dry conditions promote afterripening or loss of dormancy in the seed. How then do some of the seeds manage to persist in cultivated soil when this occurs? Lack of germinative conditions—moisture, oxygen, or a suitable temperature—may prolong the life of the seed, but only temporarily. We have found that seeds can be forced into a dormant state in very moist

TABLE 9. PERCENTAGE GERMINATION OF NONDORMANT WILD OATS WHEN DEHULLED AFTER 0-32 HR OF IMBIBITION AND SUBSEQUENT GROWTH WHEN INTACT SEEDS WERE DRIED FOR 7 DAYS AND REMOISTENED

Period of initial wetting, hr	Percentage germination as observed on dehulling	Period of drying of intact seeds, days	Percentage dried and rewetted intact seeds showing signs of growth at:			
			1 day	2 days	4 days	6 days
Nil	0	7	12	55	93	99
8	0	7	21	71	84	91
16	0	7	28	79	95	95
24	60	7	58	84	87	94
32	83	7	60	81	85	93

From Banting (1966).

soil. This is not too surprising because other methods of induction have been reported (Naylor and Christie 1956; Hay and Cumming 1959). We also found out, as did Johnson (1935), that dormancy was intensified when dormant seeds were dried after being subjected to conditions normally suitable for germination. In either case, the dormancy can prolong the life-span of wild oats considerably (Table 10).

LOSS AND GAIN OF DORMANCY

Loss and subsequent induction of dormancy in the seed can arise in the following manner. After harvest, when the seeds are on or near the soil surface, drying under warm conditions may cause a large percentage of the seeds to afterripen or lose their dormancy. Rain at this time could

TABLE 10. PERCENTAGE DORMANCY AND MORTALITY OF WILD OAT SEEDS SOAKED IN SOIL AT 60% MOISTURE FOR 4, 8, AND 10 DAYS AT TEMPERATURES OF 5, 10, 15, 20, AND 25°C, WITH AND WITHOUT SUBSEQUENT DRYING AT 21 ± 1°C FOR 7 DAYS

Temp., °C	Days of soaking	Soaked only		Soaked and dried	
		Dormant	Dead	Dormant	Dead
5	0	2.3	3.8	2.3	3.8
5	4	5.6	1.8	1.1	1.4
5	8	11.6	6.2	3.2	3.0
5	10	13.7	1.8	1.2	0.5
10	0	1.2	4.2	1.2	4.2
10	4	7.6	1.2	1.5	4.2
10	8	16.6	2.2	5.2	1.0
10	10	30.2	2.0	8.0	1.2
15	0	1.7	3.6	1.7	3.6
15	4	6.6	0.8	5.1	0.2
15	8	25.9	1.0	30.5	0.8
15	10	49.7	1.8	53.8	4.2
20	0	1.8	2.5	1.8	2.5
20	4	14.2	2.0	26.0	1.0
20	8	34.2	6.0	57.5	3.5
20	10	40.5	7.2	71.2	3.5
25	0	1.0	5.6	1.0	5.6
25	4	23.8	1.8	24.0	1.5
25	8	33.5	14.2	31.8	13.0
25	10	33.5	23.5	44.0	23.5

From Banting (1966).

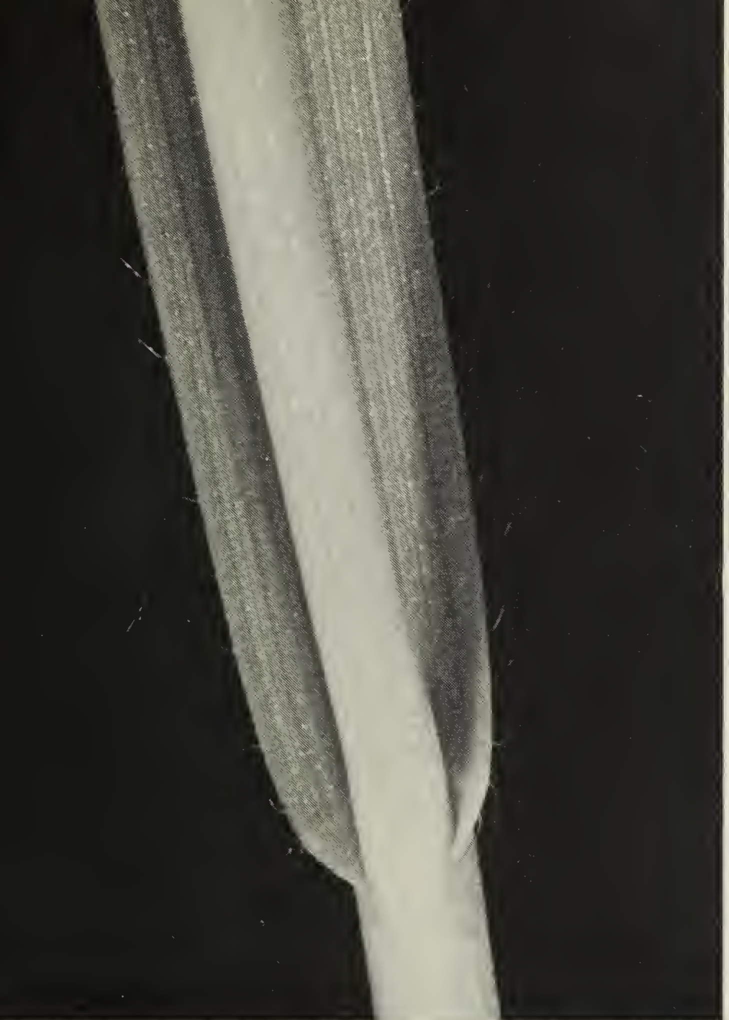
WILD OAT IDENTIFICATION

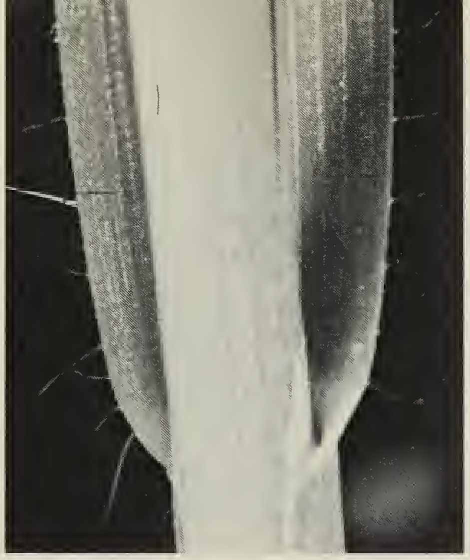
Identification of wild oat seedlings growing in wheat or barley is sometimes a problem. When viewed from above the first full leaf of the wild oat has a counterclockwise twist. Wheat and barley leaves curl clockwise.

The young leaves and sheaths of these species differ also. Barley has long, smooth auricles that clasp the stem; wheat has shorter, hairy auricles and the wild oat leaf has no auricles. Also the leaf margins of wild oats have hairs.

Distinguishing barley from wild oat seedlings is easier than with wheat. Until some experience has been gained, identification should be confirmed by digging up the young plants. Loosen the soil around the seedlings, lift them out carefully, and identify the seeds attached to the shoots.

Auricles on wheat.





Left: auricles absent on wild oats. Above: hairs on leaf margins of wild oats.

Auricles on barley.

cause many of the seeds to grow, depending on the amount received and on having suitable temperatures and an adequate supply of oxygen. However, not all the seeds will germinate because they do not afterripen uniformly. The seedlings that grow in the fall will be killed by freezing (Aamodt and Platt 1934).

During the early part of the next spring, dormancy can be induced in some of the seeds under wet soil conditions and even at low temperatures (*see* Table 10). Some of this dormancy may be lost by subsequent drying as the soil is warmed, but the seeds that remain dormant can be forced into a deeper state of dormancy by exposure to germinative conditions and subsequent drying. Much of this dormancy may be lost again if summer conditions are hot and dry. Lack of moisture often prevents germination at this time. If rain occurs and conditions are hot and humid, some of the seeds may become dormant again. Even at optimum temperatures of 15-27°C a small percentage may be dormant. Thus, the wild oat is well adapted to survive and persist in our cropland.

CULTURAL CONTROL

A number of cultural practices to control wild oats have been developed in the past 40 years and all have some merit and some limitations. These include the use of (*a*) summerfallow, (*b*) delayed seeding, (*c*) postseeding cultivation, (*d*) greenfeed crops, (*e*) fall tillage, (*f*) fall-seeded crops, such as fall rye, and (*g*) forage crops, such as grasses and legumes.

A single wild oat plant may shed 250 or more seeds and only a few plants are needed to maintain or increase the supply in the soil. Thus, if you obtain 99% control of an infestation of 120 plants / m^2 (*100 / sq yd*), the single plant that is left could maintain the supply or increase it slightly. Many farmers sow early in the spring or as soon as the soil is fit to make the best use of the available moisture. However, because early-seeded crops are usually the most heavily infested, some growers have increased their use of summerfallow to try and check their infestations. As mentioned above, we reduced a heavy infestation by 95% by summerfallowing for one season and delaying seeding the second season until early June. However, summerfallow is costly, and delayed seeding can result in reduced yields if rain does not occur soon after the crop is planted. Cultivation should be shallow and as thorough as possible. Deep burial of seeds is undesirable and deep tillage dries out the soil.

DELAYED SEEDING

Delayed seeding and the use of an early-maturing barley crop is considered to be one of the best methods of cultural control. Shallow cultivation in early spring can be used to promote the emergence of wild oats and reduce the period of delay. With cultivation the delay might be

10-14 days; without cultivation it could be up to 21 days. A delay of this magnitude increases the risk of injury to the crop from fall frost with a possible loss in yield and grade.

Although some people believe that, for effective killing by tillage, wild oats should be allowed to grow until the three-leaf stage (10-12.5 cm high; *4-5 in.*), the value of this practice or of such a delay is questionable. Even if some transplanting occurs as a result of cultivating in cool, moist conditions, or as a result of rain after cultivation, the surviving seedlings are weakened and can usually be killed by harrowing when the soil is warm and dry. Furthermore, the wild oat seedling is not readily cut into segments, especially if the cutting edge of the disc or cultivator is a bit dull or coated with moist soil. Frequently, the whole seedling is uprooted or it may be cut below the node where the secondary root system develops. In either case, the seedlings are left pretty well intact. Thus, if transplanting is possible, dragging the young plants onto the surface of the soil by harrowing or rod weeding when the weather is warm and dry will improve control.

Experiments with delayed seeding were carried out in the Prairie Provinces in the period 1952-57. Wild oat control, on the average, ranged from 12 to 94% (Table 11). Yields were light and returns from barley with delayed seeding were unpronounced or lacking. In tests with wheat, yields were reduced when seeding was delayed.

Commercial fertilizers can help in controlling wild oats. When seeding is delayed, fertilizers help produce vigorous and competitive crop plants. Phosphate fertilizers, such as 11-48-0, reduce the period required for the crop to mature, which is important when the crop is sown late. A heavier than normal seeding rate may be useful when seeding is delayed. A heavy stand of crop competes strongly against late-emerging wild oats and also matures more rapidly than a light stand.

POSTSEEDING CULTIVATION

Wild oats can be controlled by cultivation after seeding if the plants start growth ahead of the crop and if the soil surface is dry. With this method, seeding should be a little deeper than usual and cultivation should be completed before the grain sprouts are 19 mm (*3/4 in.*) in length. A rod weeder is recommended for this cultivation, but a cable weeder or flexible harrows can also be used. The tillage operation should be shallow and done with care to reduce possible crop injury.

Excess trash, shallow seeding, compacted soil, or unfavorable weather may make postseeding cultivation difficult or impossible. If postseeding cultivation is contemplated, seeding should be done with care and packing omitted because a fair amount of packing would be supplied by the subsequent rod weeder operation.

TABLE 11. EFFECT OF DELAYED SEEDING ON YIELDS OF WHEAT AND BARLEY AND WILD OAT CONTROL IN THE PRAIRIE PROVINCES, 1952-1957

Location	No. of years	Grain, tonnes / ha (*bu / ac*) Normal seeding	Grain, tonnes / ha (*bu / ac*) Delayed seeding	Wild oat plants / m^2 (*sq yd*) Normal seeding	Wild oat plants / m^2 (*sq yd*) Delayed seeding	Percentage control of wild oats
BARLEY						
Brandon	5	1.73 (*32*)	1.57 (*29*)	49 (*41*)	43 (*36*)	12.2
Indian Head	5	0.81 (*15*)	1.13 (*21*)	186 (*156*)	52 (*44*)	71.8
Melfort	4	1.46 (*27*)	1.94 (*36*)	60 (*50*)	13 (*11*)	78.0
Regina	5	1.46 (*27*)	0.81 (*15*)	40 (*34*)	32 (*27*)	23.0
Swift Current	2	—	—	52 (*44*)	5 (*4*)	90.9
Lethbridge	4	1.62 (*30*)	1.57 (*29*)	19 (*16*)*	1 (*1*)*	93.8
Lacombe	5	2.00 (*37*)	2.32 (*43*)	183 (*154*)	55 (*46*)	70.1
WHEAT						
Indian Head	5	2.21 (*33*)	1.41 (*21*)	38 (*32*)	7 (*6*)	81.2
Regina	5	0.73 (*11*)	0.54 (*8*)	202 (*170*)	11 (*9*)	94.7
Swift Current	2	—	—	39 (*33*)	5 (*4*)	93.9
Lethbridge	4	1.34 (*20*)	1.01 (*15*)	44 (*37*)*	2 (*2*)*	94.6

From Can. Dep. Agric. Publ. 1044 (1959).
* Culm counts, not plant counts.

GREENFEED CROPS

Greenfeed crops, such as oats, can be used to help grow out wild oats. To prevent seed production the crop should be cut when the panicles of the wild oats start to emerge from the sheath. Wild oat plants cut 4 days after pollination of the florets in the tip of the panicle can produce a few seeds that will germinate. To prevent regrowth the field should be tilled and a program of partial summerfallow carried out.

FALL TILLAGE

Fall tillage may be useful in promoting the germination of wild oats after harvest if the seeds have been exposed to warm dry weather for 2-3 weeks. Its value is questionable if the weather is cool and moist. If tillage is used, shallow coverage of the seed is desirable. The use of a heavy-duty cultivator that leaves the stubble standing to collect snow and prevent soil erosion by wind is recommended.

The effectiveness of fall tillage depends on the amount of dormancy in the seed and the number of seeds on the ground with or without intact awns. Seeds with awns will have shattered naturally and those without will probably have passed through the combine. If the seeds ripen under warm, dry conditions, dormancy is not as deep-seated as in seeds that ripen under cool, moist conditions. If seed dormancy is shallow, the seeds can afterripen or lose their dormancy rather fast. Seeds with intact awns work their way into the cracks, under debris, and into the soil as they are moistened and dried. These seeds are in a better position to germinate than those remaining on the soil surface. Subsequent tillage to cover the latter may bring some of the buried seeds to the surface again.

The use of fall cultivation is debatable and depends on soil and climatic conditions. A very light tillage may stimulate germination, but it reduces the amount of snow cover and increases the hazard of soil erosion. In most areas of the country a good trash cover is to be desired.

FALL-SEEDED CROPS

Fall-seeded crops, such as fall rye and winter wheat, can be used to advantage to check wild oats in areas where these crops are grown. Partial fallow before planting reduces the infestation and the wild oats that grow after seeding are killed by freezing. Fall-seeded crops begin growth early in the spring and thus tend to smother the wild oats that germinate later. Fall-seeded rye is generally more vigorous and competitive than winter wheat.

FORAGE CROPS

Forage crops, such as grasses and legumes, left down for a number of years may provide control of wild oats. Tests indicate, however, that

wild oat seeds can remain alive under sod for longer periods than in cultivated soil (Leighty 1958).

USE OF FERTILIZER

The use of phosphate fertilizer for hastening maturity when seeding was delayed was referred to above. It should be remembered, however, that wild oats compete strongly with spring wheat and respond equally well to fertilizer treatment (Sexsmith and Pittman 1963). Thus, wheat yields may not be increased if infested fields are fertilized and no attempt is made to control the wild oats. This should be kept in mind when planning the best use of fertilizer.

THE EFFECT OF BURNING

Burning of straw windrows or stubble to get rid of trash or to destroy wild oat seeds is not recommended. It increases the hazard from soil erosion, decreases the amount of snow cover, and does not eliminate the wild oats. However, it may have some application in problem areas in the spring where straw has piled up around a pothole or slough. We have destroyed a large number of seeds in straw windrows by burning immediately after harvest depending on the amount of straw and other conditions (Table 12; Molberg and Banting 1973). Seeds that fell into cracks or worked their way into the soil were not included in the test. Many of the seeds that shattered before harvesting would be in this category.

TABLE 12. EFFECT OF BURNING STUBBLE ON WILD OAT SEEDS, AVERAGES, 1961-1963, REGINA, SASK.

Time of treatment and seed collection	Treatment	Dead, %
Immediately after harvest	Straw spread, not burned	7
	Straw spread, burned	81
	Straw windrowed, burned	86
3 weeks after harvest	Straw spread, not burned	6
	Straw spread, burned	59
	Straw windrowed, burned	66
Following spring	Straw spread, not burned	22
	Straw spread, burned	63
	Straw windrowed, burned	67

From Molberg and Banting (1973).

CAUSES OF FAILURES

Failure in the cultural control of wild oats is attributed to (*a*) unfavorable weather conditions, (*b*) failure to use clean seed, (*c*) early seeding of crops on infested land, (*d*) deep cultivation, which buries the seeds, (*e*) fall cultivation before the wild oats have dried out properly, and (*f*) cultivation of wild oat stands on moist, cool days (Harrington 1955).

CHEMICAL CONTROL

The herbicides currently suggested for use are highly selective and should be handled and applied with care. Calibration, cleaning, and maintenance of spray equipment is important and should not be neglected. Bulletins are available on calibration and care of sprayers, and methods of application are supplied in detail. The instructions on the label are supplied for your protection and should be followed closely. The detailed information required on formulations, rates, and cost of chemicals is available from provincial government publications, which are issued annually. Any rates given herein refer to the active ingredient.

TRIALLATE (Avadex BW, Monsanto Canada Ltd.)

Formulations commonly used: Liquid — 400 g of active ingredient / litre (*4 lb / gal*).

Granular — 10% active ingredient.

Crops: Wheat, barley, flax, rapeseed, and mustard.

Method of application: Triallate should be applied in water at 112 litres / ha (*10 gal / ac*) at 207 kPa pressure (*30 psi*). The chemical should be mixed immediately into the soil on the day of spraying. A considerable amount of chemical can be lost under warm or windy conditions if incorporation is delayed. Incorporation to a depth of 5 cm (*2 in.*) is recommended; deep incorporation dilutes the effect of the chemical. A disk-type implement is considered best for mixing. However, two harrowings at right angles to each other are often adequate on summerfallow. The cultivator and rod weeder are not efficient implements for mixing.

For flax, rapeseed, and mustard apply triallate before planting and incorporate immediately to a depth of not more than 5 cm (*2 in.*) on the same day. Seeding should be shallow and packing is recommended.

For wheat, sow the crop at a depth of 6-8 cm (*2½ -3 in.*), apply triallate after planting, and incorporate immediately to a depth of 5 cm (*2 in.*) by two harrowings at right angles to each other. Triallate can also be applied during planting from a boom mounted behind the disker. The spray can then be directed into the soil as it is turned up so that the seed remains below the layer of treated soil.

For barley, triallate can be applied before or after seeding. Application after seeding can improve the safety margin of some varieties.

Fall application: Triallate can be applied and incorporated in late October in areas where soil erosion is not a problem. However, burning or excessive loss of straw should be avoided. Satisfactory control can be obtained if loss of chemical is not extensive or the soil containing the chemical is not too dry when spring growth commences.

Mode of action: The lethal effect of triallate on wild oats is caused by the chemical that is taken up through the underground part of the shoot and not by the roots. The sensitive part of the young shoot is the actively growing tissue of the base of the leaf that surrounds the stem apex, which eventually forms the panicle (Banting 1970). Wild oat seedlings produce some growth before death. As growth ceases, the leaves become brittle and bluish green in color. Seedlings that germinate in the treated layer of soil grow less than those that germinate below this layer. The latter are killed but the height of the shoots above ground increases as the seedlings grow from greater depths in the soil. The reason for this is that it takes longer for the sensitive tissue to be pushed up into the treated layer when the seeds are deep and during that time the tip or oldest part of the first leaf is extended more and more above ground. Thus, a wild oat seedling may barely emerge from just below a 5-cm (*2-in.*) treated layer, but a seedling from a depth of 15 cm (*6 in.*) may reach a height of more than 5 cm (*2 in.*) above ground before it dies. On the other hand, triallate applied as late as the two-leaf stage has killed wild oats in certain experiments (Banting 1967).

Flax and barley are more tolerant of triallate than is wheat. This accounts for the differences in rates of application. However, if wheat is planted 1.3 cm (*0.5 in.*) or more below the treated layer of soil the safety margin of the crop is increased considerably. Wild oats are more sensitive than wheat and, as pointed out above, the seedlings are susceptible regardless of the depth of the seeds in the soil. Differences due to placement are attributed to inherent differences in tolerance of the two species and to increased tolerance with age. Wheat is not only more tolerant of triallate than is wild oats but its tolerance increases with age and its sensitive tissue is pushed up into the treated layer at a later stage than in wild oats. Wild oats also become more tolerant with age, but the plant is inherently much more sensitive than wheat. This and the rapid upward movement of its sensitive tissue into the treated soil make it susceptible to injury and death.

Triallate is a volatile compound and evaporates quickly from the soil surface. Loss from evaporation is greatly reduced if the chemical is promptly mixed with the soil. Triallate also needs a small amount of soil moisture to activate it. For this reason excessive drying of the soil by

Wild oat infestations can be reduced to a low level in three to four years with a high degree of control each year.

tillage should be avoided before triallate is applied. However, if treated soil is dry the chemical can be activated by rainfall and the wild oats will still be killed if they have not advanced beyond the two-leaf stage.

Triallate is strongly adsorbed or bound to organic matter in the soil. The adsorbed portion of the herbicide is not available to plants. Thus, triallate is less effective, kilogram for kilogram, in soils with high organic matter than in soils with low organic matter content. Excessive amounts of straw may reduce effectiveness by hindering incorporation of the chemical.

Persistence: Triallate is broken down by microorganisms once it is mixed in the soil. Its rate of disappearance depends on soil moisture, temperature, and other factors. Under warm, moist conditions, 0.84 kg / ha (*12 oz / ac*) may disappear in 6-8 weeks. Under dry conditions it can persist in the soil for longer periods. This is the reason why oats should not be sown the year after application of triallate. When triallate is applied in late fall, 70-75% may be present in the spring to control the wild oats (Smith 1970). If the amount remaining is sufficient to give satisfactory control, then similar results should be obtained by applying this amount of chemical in the spring when conditions are optimum for germination. Fall tillage reduces the amount of snow cover and increases the possibility of soil erosion. Satisfactory control can be obtained from fall application but its main advantage may be in treating small problem areas.

DIALLATE (Avadex, Monsanto Canada Ltd.)

Instructions for using diallate are not included here, because the chemical is not readily available in Canada. The use of the same trade name was confusing when triallate (Avadex BW) was introduced 3 years after diallate (Avadex). The letters BW refer to barley and wheat, and wheat is more tolerant of triallate than diallate. This may help in distinguishing the two chemicals. However, since diallate was withdrawn, we will no doubt mistakenly refer to triallate as Avadex and so perpetuate the confusion.

BARBAN (Carbyne, Gulf Agricultural Chemicals)

Formulation commonly used: Liquid — 120 g of active ingredient / litre (*1.2 lb / gal*).

Crops: Wheat, barley, flax, rape, sunflowers, and mustard.

Method of application: Barban should be applied in water at 45 litres / ha (*4 gal / ac*) and at not less than 310 kPa (*45 psi*). Directing nozzles 45° forward and lowering the boom height improves results. Spray drift can be reduced further under windy conditions by using flood jet nozzles at a spacing of 100 cm (*40 in.*), directing them 45° forward, and adjusting boom height.

Barban must be applied at the two-leaf stage of the wild oats, that is, from appearance of the second leaf until the appearance of the third leaf. Best results are obtained when growing conditions are such that the wild oats reach the two-leaf stage in less than 11 days after emergence. When growth is slow, spraying should be done before the 14th day after emergence.

The rates of barban suggested for wheat, barley, and flax have been 0.28-0.35 kg / ha (*4-5 oz / ac*) of active ingredient since 1963. The 0.35 kg / ha (*5 oz / ac*) rate should be used in heavy infestations, where it is difficult to obtain good coverage because of shading, or under adverse growing conditions, such as extended low temperatures, lack of moisture, or excessive heat or wind.

Barley and wheat may be injured if they are treated at or after the four-leaf stage, or 14 days after they have emerged.

Flax is not as tolerant as wheat and barley. It must not be sprayed at or before the cotyledonary stage or after the 12-leaf stage.

Mode of action: Barban is taken up through the leaf but is not readily moved through the plant. In placement studies, best results were obtained when droplets were placed in the angle of the two leaves. The apparent reason for best results being obtained with high pressures and with the nozzles directed forward is better coverage of the wild oat seedlings.

Barban kills or stunts the growth of wild oats. The effect is gradual and may not be evident for 2-3 weeks. The ligule area of the first leaf of wild oats is the most sensitive part. Affected seedlings turn a blue-green color, become thick and brittle, and stop growing. The degree of control largely depends on the uniformity of emergence of the wild oats and on competition from the crop.

Persistence: Barban applied to soil persisted at detectable levels for about 2 months. When applied at recommended rates, only trace amounts of barban could be detected within 3 weeks in most soils. Under normal conditions, microbial breakdown of barban in soil is fairly rapid.

TRIFLURALIN (Treflan, Elanco Products)

Formulation commonly used: Liquid — 400 g of active ingredient / litre (*4 lb / gal*).

Crops: Rapeseed, sunflower, and mustard.

Other weeds controlled: Green foxtail, barnyard grass, wild buckwheat, rèdroot pigweed, and lamb's quarters.

Method of application: Trifluralin must be applied to the soil before planting. It should be mixed into the top 8-10 cm (*3-4 in.*) of the soil by disking immediately after spraying. For best results, fields should be worked twice by cross-disking. Trifluralin can be applied in the fall before freeze-up. If it is applied when the soil is cool (in October, before

freeze-up), loss of chemical by soil microorganisms is small. However, increasing the application rate is suggested as a precaution when the chemical is applied in the fall.

Proper placement and incorporation of the chemical in the soil are imperative for successful use. Crop residues should be thoroughly mixed into the soil by disking or by a period of summerfallow. Trifluralin is readily lost from the soil surface by photodecomposition and volatilization. Thus, it is essential to incorporate it into the soil by disking directly after spraying.

Mode of action: Because trifluralin is taken up to a greater extent by the shoots than by the roots of wild oats (Friesen and Bowren 1973) and green foxtail (Rahman and Ashford 1970), the depth of incorporation is important. Incorporation to depths below 8 cm (*3 in.*) has a diluting effect. Growth inhibition, swelling at the base of the shoots, and the development of stubby roots may be evident if the seedlings germinate in treated soil. The effect on the roots is less pronounced if the seedlings start growth below the treated soil.

Although trifluralin does not move with soil moisture, except perhaps by sheet erosion as a result of flooding, a limited amount of moisture is needed to activate it. Prolonged dry spells after treatment and incorporation in the spring can reduce the effectiveness of trifluralin in the field. The amount of organic matter in the soil also affects its activity. Tests have shown that nearly double the dosage of chemical is required to give the same control in soil with 9% organic matter as in soil with 4.5%.

The seed of rapeseed is small and must be planted at a shallow depth in a firm seedbed. The extra tillage needed to incorporate trifluralin dries out the surface soil and may cause uneven crop emergence when a dry spell occurs after planting. This can be partly overcome by packing after tillage or by applying the herbicide in the previous fall.

Persistence: Trifluralin is relatively persistent. It may be degraded by UV light, or lost by evaporation or by microbial or chemical action. Incorporation reduces the loss by volatilization and by light. High moisture and organic matter content hasten microbial breakdown.

Approximately 30% of trifluralin applied in the spring may be present at the end of the growing season. If trifluralin is applied in the fall, 70% may be present in the spring of the following year (Smith 1972). The rate of loss in either case depends on the weather.

Oats should not be planted in the year after trifluralin has been applied, since it is likely to be injured by carry-over of trifluralin.

ASULAM (Asulox F, May and Baker (Canada) Ltd.)

Formulation commonly used: Liquid — 385 g active ingredient / litre (*62 oz / gal*).

Crop: Flax.

Other weeds controlled: Asulam controls or suppresses seedlings of wild mustard, stinkweed, wild buckwheat, smartweed, and lady's thumb. The addition of bromoxynil plus MCPA at 0.21 + 0.21 kg / ha (*3 + 3 oz / ac*) improves the control of these weeds. TCA, dalapon, or 2,4-D should not be mixed with asulam because crop damage may occur.

Method of application: Asulam should be applied when the wild oats are in the two- to four-leaf stage and when the flax is 2.5-15 cm (*1-6 in.*) tall. It should be applied in 56-112 litres of water / ha (*5-10 gal / ac*) at 275 kPa (*40 psi*).

Mode of action: Asulam is taken up by the leaves and moved to other parts of the plant. It moves to the growing point where it inhibits cell division. There is severe yellowing of the leaves and stunting before the plant dies. The growing point is affected within 7-10 days but death of the plant takes longer.

Persistence: Asulam does not persist in the soil for long periods of time under conditions that favor microbial breakdown. In laboratory studies, there was a 50% reduction in 6 weeks at 20°C. Soil taken from the field 3 months after treatment did not affect growth of test plants.

Precautions: The crop should not be sprayed if it is under stress because of drought, or in hot humid weather, or if rain is expected within 4 hours.

BENZOYLPROP ETHYL (Endaven, Shell Canada Limited)

Formulation commonly used: Liquid — 200 g active ingredient / litre (*2 lb / gal*).

Crops: Wheat and rapeseed.

Method of application: Benzoylprop ethyl should be applied to wheat at the three- to four-leaf stage of the wild oats and to rapeseed at the four- to six-leaf stage of the wild oats in 45-112 litres of water / ha (*4-10 gal / ac*) at 310 kPa (*45 psi*). Temporary injury may occur if application is made before the four-leaf stage of rapeseed. Benzoylprop ethyl should not be mixed with herbicides for the control of broad-leaved weeds. An interval of 4 days should be allowed between the application of benzoylprop ethyl and the use of bromoxynil, MCPA, or bromoxynil-MCPA. An interval of 7 days should be allowed between the application of benzoylprop ethyl and the use of 2,4-D or dicamba.

Mode of action: Benzoylprop ethyl is taken up by the leaves and moves to the growing points of the plant. In wild oats, it inhibits cell elongation. The plants are stunted and seed production is greatly reduced. The chemical gives better control when applied at the late stage than at the early stage. However, a greater crop yield can be expected by checking the weed competition at the early stages. Strong competition from the crop improves control of wild oats.

Precaution: Benzoylprop ethyl should **not** be applied to the Selkirk variety of wheat.

Persistence: The chemical does not persist in the soil.

DIFENZOQUAT (Avenge, Cyanamid of Canada Ltd.)

Formulation commonly used: Liquid — 200 g active ingredient / litre (*2 lb / gal*).

Crop: Barley.

Method of application; Difenzoquat should be applied in 112 litres of water / ha (*10 gal / ac*) at 310 kPa (*45 psi*) when the wild oats are in the three- to five-leaf stage. Directing the spray nozzles 45° forward results in optimum coverage. The highest recommended rate should be used when the wild oat density is more than 108 plants / m^2 (*10 plants / sq ft*). Early treatment can result in higher yields but gives less effective wild oat control. Strong crop competition will improve the results. Hard-to-kill broad-leaved weeds and wild oats may be controlled by tank mixing bromoxynil plus MCPA ester (0.28 + 0.28 kg / ha; *4 + 4 oz / ac*) and difenzoquat. Amine formulations should not be combined with difenzoquat.

Mode of action: Herbicidal action on wild oat plants appears to be localized to the areas of spray contact. Movement of the chemical from the point of contact has not been observed. Spray deposited on leaf axils and the shoot apex resulted in the greatest activity. It appears that herbicidal activity is primarily through direct contact action. Careful attention should thus be given to obtain good spray coverage.

Persistence: Soil studies indicate no effects on soil microorganisms. Soil residues are not considered a problem because the chemical is adsorbed onto soil particles.

EPTC (Eptam, Stauffer Chemical Co., handled by Chipman Chemicals in Canada)

Formulation commonly used: Liquid — 796 g of active ingredient / litre (*8 lb / gal*).

Crops: Flax and sunflower.

Other weeds controlled: Barnyard grass, corn spurry, green foxtail, chickweed, lamb's quarters, pigweed, and others.

Method of application: EPTC should be applied to the soil in 112 litres of water / ha (*10 gal / ac*) or more at 207 kPa pressure (*30 psi*) just before planting and incorporated immediately into the soil with a disk-type implement set to cut to a depth of 10-15 cm (*4-6 in.*). The soil should be well worked and dry enough to provide good mixing. All weed growth and crop stubble should be thoroughly worked into the soil before the chemical is applied. Small seeded crops, such as flax, should

be sown **shallowly** into a firm, moist seedbed. Seeding should be done as soon as possible after the chemical is applied and mixed into the soil.

Caution — EPTC is for use on mineral soils only and should **not** be used on flax in southern Alberta, south of the Trans-Canada (No. 1) Highway. Note also that the depth of incorporation exceeds the recommended maximum of 10 cm (*4 in.*) suggested for most types of tillage in Western Canada.

Mode of action: EPTC controls susceptible species when applied before the weeds emerge. The main effect on weed seeds is during and shortly after germination of the seed. It has been shown that barnyard grass seedlings are more susceptible to EPTC when the coleoptiles are exposed to the chemical than when the roots grow in treated soil (Dawson 1963). In oats, the shoot appears to be the main area of lethal action of EPTC (Appleby et al. 1965). Presumably, this applies to wild oats as well.

Persistence: EPTC does not persist in the soil and therefore does not cause injury to other crops planted in rotation.

DINITRAMINE (Cobex, U.S. Borax; handled by Chipman Chemicals in Canada)

Formulation commonly used: Liquid — 240 g of active ingredient / litre (*2.4 lb / gal*).

Crops: Rapeseed and sunflower.

Other weeds controlled: Barnyard grass, green foxtail, lamb's quarters, redroot pigweed, green smartweed, wild buckwheat, hemp nettle, and lady's thumb.

Method of application: Dinitramine can be applied and incorporated in the fall just before freeze-up or when soil temperatures are below 10°C. Incorporation has to be thorough and deep, as indicated on the label, or crop injury may occur. Shallow cultivation in the spring is required to control early-germinating weeds. A shallow seeding depth is also specified.

Dinitramine can also be applied in the spring before seeding if the chemical can be thoroughly incorporated to a depth of 3.8-5 cm (*1½ to 2 in.*) within 24 hours of application and the seedbed left firm, moist, and free from trash. Operators should check the procedure on the label to determine the feasibility of the method. Loss of soil moisture or soil by wind erosion are factors to consider.

Precautions:

(1) Do not seed below 3.8 cm (*½ in.*).

(2) Do not seed with a disker.

(3) The tolerance of rapeseed for dinitramine is limited. Follow label instructions.

(4) Dinitramine is combustible and should be kept away from heat or open flames.

(5) The application and incorporation of herbicides in the fall to summerfallow land that is susceptible to wind and water erosion is not recommended.

Mode of action: Weed species that are susceptible to the herbicide are controlled as they germinate. Dinitramine, which exhibits only slight movement in either coarse or fine textured soils, persists in the soil long enough to provide weed control for several months. Seedling diseases, unfavorable growing conditions such as planting too early in cold soil, drought or excessive soil moisture, and deep planting may delay emergence of the seedling and retard plant growth. These conditions increase the possibility of crop damage.

Persistence: Loss of herbicide through leaching or by volatility is reported to be insignificant. Dinitramine declines steadily in the soil and less than 10% remains after 80-120 days. Soil microflora plays an important part in the degradation of dinitramine.

FLAMPROP METHYL (WL 29761, Mataven, Shell Canada Ltd.)

Formulation commonly used: Liquid — 150 g of active ingredient / litre (*1.5 lb / gal*).

Crop: Wheat.

Method of application: Flamprop methyl should be applied in 45-112 litres of water / ha (*4-10 gal / ac*) at 310 kPa (*45 psi*) when the wild oats are in the three- to five-leaf stage. Spray nozzles directed 45° forward results in optimum coverage. An interval of 4 days should be allowed between the application of flamprop methyl and the use of bromoxynil, MCPA, or bromoxynil-MCPA. An interval of 7 days should be allowed between the application of flamprop methyl and the use of 2,4-D or dicamba.

Mode of action: Flamprop methyl is an analogue of benzoylprop ethyl and it affects the wild oat in a similar manner (*see above*). However, flamprop methyl has given superior results at lower rates and earlier stages of application than has benzoylprop ethyl. Early treatment usually results in optimum yields, and vigorous crop competition improves the wild oat control.

Precaution: Flamprop methyl should **not** be applied to Selkirk wheat.

Persistence: Carry-over in the soil is not expected to be a problem.

DICHLORFOP METHYL (Hoe-Grass, Canadian Hoechst Ltd.)

Formulation commonly used: Liquid — 190 g of active ingredient / litre (*1.9 lb / gal*).

Crops: Spring and durum wheat, flax, rapeseed, and mustard.

Other weeds controlled: Green foxtail, Persian darnel, and barnyard grass.

Method of application: Dichlorfop methyl should be applied in 112 litres of water / ha (*10 gal / ac*) at 275 kPa (*40 psi*) when the wild oats are in the one- to four-leaf stage. Optimum control and crop yields can be expected if dichlorfop methyl is applied when most of the wild oats are in the two- to three-leaf stage. Directing the spray nozzles 45° forward results in optimum coverage. Do not apply if rain is expected within 4 hours after application. Mixing dichlorfop methyl with herbicides used to control broad-leaved weeds, such as 2,4-D, MCPA, and dicamba, is not recommended and results in reduced weed control. Dichlorfop methyl should be applied first, followed by an interval of at least 4 days before the application of chemicals for the control of broad-leaved weeds. Application should not be made with insecticides or liquid fertilizer.

Mode of action: Dichlorfop methyl is a systemic herbicide that causes chlorosis or yellowing of affected plants 2-3 days after application. The chlorosis then deepens for a further 7-10 days before the plant dies. Extensive yellowing is especially evident in areas of heavy weed growth.

Root growth and development can be affected by the chemical in some species of plants. Application during periods of drought may result in reduced performance.

Persistence: Dichlorfop methyl is broken down fairly rapidly in the soil. However, some carry-over has been indicated in heavy clay soil 1 year after the application of 1.68 kg / ha (*24 oz / ac*). Treated fields should not be grazed nor treated straw used for livestock feed.

BARBAN + BENZOYLPROP ETHYL (Carbyne + Endaven)

Formulation commonly used: Liquid — tank mix.

Crop: Wheat.

Method of application: A mixture of barban at 0.14 kg / ha (*2 oz / ac*) plus benzoylprop ethyl at 0.56 kg / ha (*8 oz / ac*) has been used to control wild oats in wheat at a later stage than when barban is used alone. The mixture should be applied at the three-leaf stage of the wild oat in 56 litres of water / ha (*5 gal / ac*) at 310 kPa (*45 psi*) pressure. Early treatment usually results in the highest yield. Directing the spray nozzles 45° forward provides optimum coverage. Mixing additional herbicides such as 2,4-D and MCPA, which are used to control broad-leaved weeds, with the above combinations is **not** recommended. An interval of 4 days should be allowed between the application of barban plus benzoylprop ethyl and the use of bromoxynil, MCPA, or bromoxynil–

MCPA. An interval of 7 days should be allowed between the application of barban plus benzoylprop ethyl and the use of 2,4-D or dicamba.

Mode of action: The mixture of barban and benzoylprop ethyl in the amounts referred to above has effectively extended the use of barban beyond the two-leaf stage of the wild oat. At the same time benzoylprop ethyl is more effective at the three-leaf stage when it is applied in the mixture than when it is applied alone.

Persistence: *See* section on barban and on benzoylprop ethyl.

CULTURAL AND CHEMICAL PROGRAMS

A wild oat infestation can be reduced to a low level in 3-4 years if a high degree of control is obtained each year. This can be accomplished by the use of summerfallow, cultural control, or chemical control, alone or in combination. With the exception of summerfallowing or early cutting for greenfeed, it is not possible to obtain complete control with any one method without mowing or roguing the plants that escape. Eradication in cultivated soil requires the use of clean seed, and complete control for at least 7 years. Thus, it may seem impracticable except on a small scale. An infestation may appear too light to warrant treating after as little as 2-3 years of satisfactory control, but the plants that subsequently appear will soon replenish the supply of seeds in the soil. Under these conditions you may avoid treating for a few years but reinfestation will occur again.

Experience in the use of herbicides can be gained by treating problem areas with either a soil-applied or a postemergence chemical. Accurate calibration of the sprayer and proper application are important. The soil-applied chemicals are more difficult to use but they provide a longer period of control. Excessive drying of the soil by preseeding tillage must be avoided. Application of triallate when seeding conditions are optimum, and when there is enough moisture for germination, should ensure a high degree of control. Prompt incorporation is essential, and packing conserves moisture. If moisture is insufficient for germination of the crop, the chemical may be temporarily inactive and the wild oats may emerge from depths below the crop. However, if sufficient rain occurs to germinate the crop, the wild oats may still be controlled if they are not beyond the two-leaf stage.

Triallate may be applied in the fall where wind erosion is not a problem. The disadvantages are loss of stubble, less trapping of snow, increased cost of granular material, loss of chemical before spring germination, and the inability or difficulty in sowing wheat below the treated layer the next spring as recommended. Breakdown of the chemical by microorganisms in the soil can be minimized by treating in late October or just before freeze-up.

The incorporation of herbicides in the fall to summerfallow land that is susceptible to wind and water erosion is **not** a good agronomic practice, nor is the burning or unnecessary destruction of straw. Fall application may have some advantage in areas where soil erosion is not a problem, in areas where incorporation of chemical by two diskings in the spring could deplete soil moisture, or in small areas where access in the spring is difficult. Satisfactory control can be obtained from fall application if loss of chemical is not extensive or the soil containing the chemical is not too dry when spring growth begins. Fall tillage reduces the amount of snow cover and increases the possibility of soil erosion.

Trifluralin is subject to similar problems. Immediate incorporation is important and its availability to the plants is affected by the amount of organic matter in the soil, as with triallate. However, deep 8-10 cm (*3-4 in.*); thorough incorporation (two cross diskings) is specified before the oilseed crops are seeded. Because this dries out the soil surface in the spring before sowing a small-seeded crop, such as rapeseed, fall application is advisable. With fall application, a slight increase in rate of chemical is suggested. The disadvantages are the same as those listed above for triallate, except trifluralin is used in oilseed crops and it controls a greater number of weed species.

Barban presents an economically attractive treatment for wild oat control. A high degree of control may result in a high yield return if the bulk of the wild oats germinate early and are in the two-leaf stage at time of treatment. Practices that promote early, uniform emergence in the spring improve the use of barban. Satisfactory yield returns may still be obtained when control is decreased by late-emerging wild oats. This can be determined by leaving some untreated strips in the field.

Asulam can be used in flax when the wild oats are in the two- to four-leaf stage and the crop is 2.5-15 cm (*1-6 in.*) high. The effect appears gradually as growth ceases and the leaves of the wild oats become yellow. Asulam provides some control of wild mustard and stinkweed seedlings and suppresses wild buckwheat and smartweed. The application of asulam should be timed to give the best control of wild oats.

Benzoylprop ethyl can be applied at the three- to five-leaf stage of the wild oats in wheat. Early treatment may result in higher crop yields but less effective wild oat control. Control will be improved by strong competition from the crop, but some of the stunted plants will produce seed even with late treatment. There may be little merit in late treatment if potential yield increases are low and the field is to be summerfallowed the following season. An interval of 4-7 days must be allowed between its use and herbicides for broad-leaved weed control.

Difenzoquat was registered for use in barley in 1974. As with benzoylprop ethyl, crop competition affects the degree of control, and

time of application affects crop yield. Good spray coverage is important. Difenzoquat has been successfully tank-mixed with bromoxynil + MCPA to give control of wild oats and certain hard-to-kill broad-leaved weeds.

EPTC and dinitramine are soil-applied herbicides that can be used to control a number of weeds besides wild oats in certain oilseed crops. Weed growth and crop stubble or excess trash need to be well worked into the soil before either herbicide is applied. EPTC should be applied before planting and incorporated immediately to a depth of at least 10 cm (*4 in.*). Dinitramine should also be applied before planting and mixed in the soil to a depth of about 5 cm (*2 in.*). To accomplish this, the soil has to be worked to a greater depth than 5 cm (*2 in.*). Both herbicides have to be incorporated thoroughly and shallow seeding of the crop into a firm seedbed is required.

Flamprop methyl is a new postemergence herbicide, which will be available in limited amounts in 1977. It is similar in composition to benzoylprop ethyl but has given superior wild oat control in wheat at an earlier stage of growth and at lower rates.

Dichlorfop methyl is another new postemergence herbicide, which will be in limited supply in 1977. It can be used to control wild oats and green foxtail in wheat, flax, or rapeseed. It has also been effective against Persian darnel in limited trials. Best results can be expected if dichlorfop methyl is applied when the majority of the wild oats are in the two- to three-leaf stage.

The mixture of barban plus benzoylprop ethyl in the amounts referred to above has given satisfactory control of wild oats in wheat when applied at the three- to four-leaf stage of the wild oats. Early treatment, at the three-leaf stage, is advisable to obtain optimum crop tolerance and yield. The mixture is **not** intended to replace treatment with barban alone when the majority of the wild oats are in the two-leaf stage. The mixture loses its effectiveness if other chemicals are added.

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Buyers are selective of wild oat infested grain.

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